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Fig. 4

Control of Grape Diseases and Insects in the Eastern United States

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CONTROL OF GRAPE DISEASES AND INSECTS IN THE EASTERN UNITED STATES

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Diseases and insects can seriously reduce the commercial value of grapes grown in the Eastern United States. It is better to prevent disease and insect damage by sprays or cultural practices than to try to stop them after they have appeared in the vineyard. The damage that occurs varies considerably in different regions and from year to year.

Weather conditions during critical periods for infection affect the development and spread of organisms causing grape diseases and, therefore, the number of sprays needed and the intervals between them. In some years one or two applications of a fungicide may be sufficient; in other years the five or six sprays generally recommended may be inadequate. An understanding of the diseases and organisms that

cause them will enable you to adapt a spray schedule to your particular needs.

Grape diseases generally are more prevalent and difficult to control in the Southeastern States because of prevailing high temperatures, abundant rainfall, and long growing season. The varieties of grapes grown influence the amount of disease. The vinifera, or European, varieties are very susceptible and are difficult to grow successfully east of the Rocky Mountains, except in a few favorable districts. Varieties of the American bunch grape vary as to susceptibility to disease, whereas muscadine grapes are highly resistant to the more destructive diseases.

Grapes are subject to attack by many kinds of insects. Most of the economically important insects are discussed in this bulletin. For precautions concerning the handling and use of pesticides, see page 26.

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DISEASES PRINCIPALLY OF AMERICAN BUNCH GRAPES

Black Rot

Black rot, a fungus disease, is the most widespread disease of grapes.² In the eastern grape-producing districts, it causes greater loss than all other diseases combined. Black rot is generally distributed east of the Rocky Mountains, but it is most prevalent and destructive east of the Mississippi River. It is especially destructive in the hotter, more humid parts of this region.

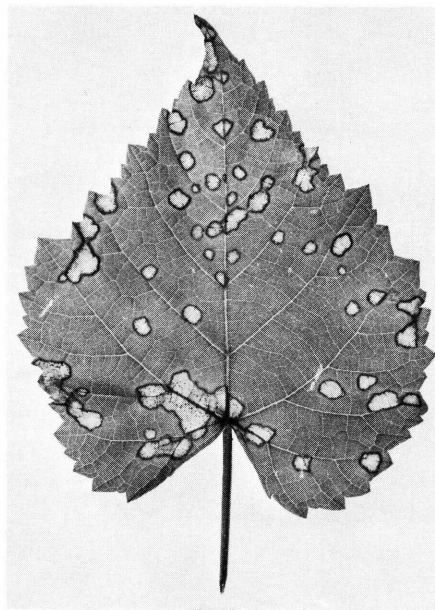
All vinifera varieties of grapes and many of the American bunch grapes are highly susceptible to black rot.

The following varieties of American bunch grapes are moderately resistant to black rot and are of fair to good quality: Beta, Campbell Early, Clinton, Delaware, Elvira, Lutie, Missouri Riesling, Moore Early, Norton, Portland, Sheridan, and Worden.

The black rot fungus attacks the leaves, young canes, tendrils, and fruit. Only the youngest tissues are susceptible, except for the fruit, which may become infected until it is almost fully grown. Rotting of fruit after it begins to color is generally caused by other fungi. Infection may occur any time in which the vine tissues remain wet for 12 hours or more.

About 2 weeks elapse between the time of infection and the appearance of typical spot symptoms. Although spotting occurs on the leaves (fig. 1) and vines early in the spring, it usually goes unnoticed until midsummer, when the nearly half-grown berries begin to discolor and dry.

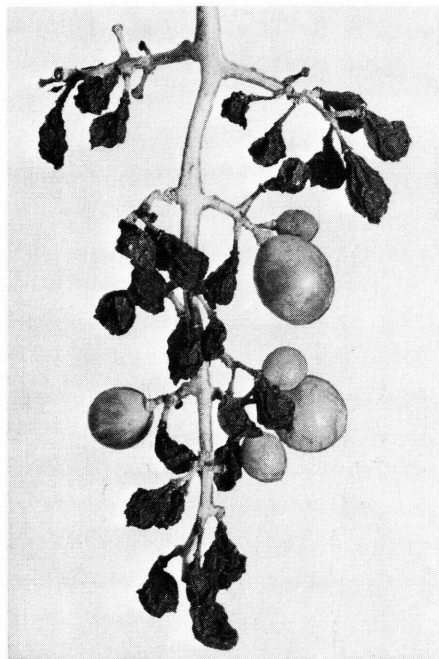
Symptoms of rot on the berries first appear as light-brownish, soft, circular spots. The spots enlarge rapidly and, within 2 or 3 days, discolor the entire berry. The decaying berries soon shrivel and, in 7 to 10 days, change to black, hard, wrinkled mummies, which may remain attached to the bunch (fig. 2). The mummi-



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FIGURE 1.—American bunch grape leaf attacked by black rot fungus.

² The causal organisms of grape diseases are given on p. 34.



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FIGURE 2.—Cluster of grapes showing black rot injury. Note mummified berries.

fied berries are covered with barely visible pimplelike structures, which produce infective spores. These structures may also be seen in the spots on the leaves, tendrils, and canes.

The extent of the disease from season to season depends, in part, on weather conditions during spring and early summer. Primarily, however, it depends on the amount of diseased material that is carried over on the vines, on old infected tendrils on the trellis wires, and on fallen leaves, as well as on diseased fruit from the previous season. New spores are produced during warm, moist weather in the spring on such old infected plant parts, and these infect young leaves and shoots.

The early season sprays are very important in the control of black rot. If the vines are not sprayed early with the proper fungicide, the fungus may attack the young shoots and leaves and build up a reservoir of spores capable of infecting the fruit later in the season.

Fungicide to control black rot should be applied:

1. When new shoots are 6 to 10 inches long.
2. Three to 5 days before bloom.
3. Immediately after bloom.
4. Ten to 14 days after bloom.
5. At 10 to 20 day intervals until berries are nearly full size. More frequent sprays are needed if leaves show black rot or the season is wet.

The choice of fungicide for black rot control depends on cost, ease of preparation, and other diseases which may be present.

Ferbam is most generally recommended for black rot control. Other fungicides which may be used are zineb, captan, and folpet. Fixed copper-lime and bordeaux mixture (8-8-100) are also effective but may cause some injury to young foliage and are fully compatible only with methoxychlor among the insecticides listed in the table on page 28.

Downy Mildew

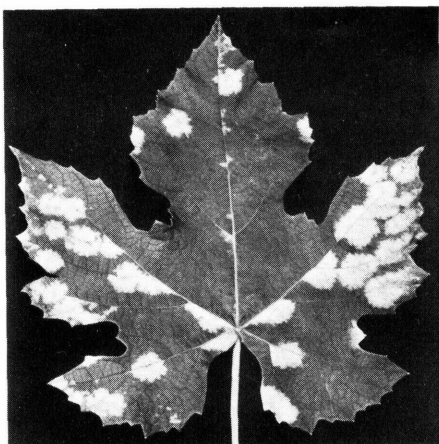
Downy mildew, a fungus disease, primarily attacks grape leaves. It damages the leaves in unsprayed vineyards in the Ohio River Valley, the Great Lakes region, and the Northeastern

States as far south as southern Virginia. Since the disease is more severe in cool, moist weather, it is of minor economic importance in the South.

Older leaves in the center of the vine are the first to become infected. The disease spreads toward the leaves at the end of the canes as they mature. By autumn, on highly susceptible varieties, even young leaves may die and fall. If the season has been unfavorable for the spread and rapid growth of the fungus or if the grape variety is resistant, only a few of the oldest leaves may show the symptoms.

The fungus overwinters on old diseased leaves on the ground. Weathering and decomposition free the spores in spring, and splashing rain or wind causes some of them to reach the new leaves or the berries, where infection starts. Damage to the leaves, usually minor before late summer, is greatest during August and September.

First signs of infection on the leaves are light-yellow spots (fig. 3). Then a white moldy growth of fungus threads and spores forms on the undersides of the leaves. The spots may be few or many. When they merge, they can cover most of the leaf. The affected leaves eventually turn brown, become dry and crumpled, and fall. The exposed berries may be scalded by the sun, or, if the vines lose their leaves before the ripening season, berries do not mature normally.

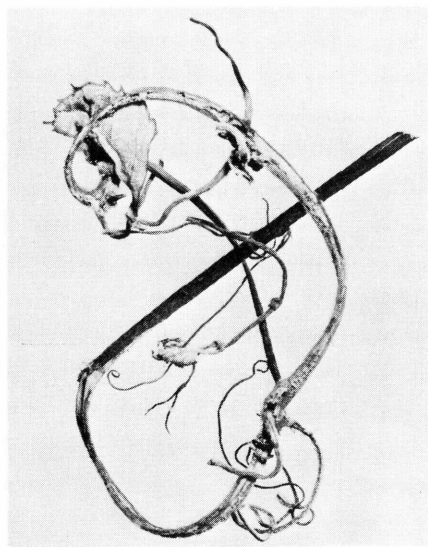


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FIGURE 3.—Downy mildew on upper side of grape leaf. Spots are yellow. To be sure disease is downy mildew, underside should have identical spots that are downy.

Downy mildew may also attack and cause severe malformation of shoots, tendrils, or berries early in the season when they are tender (fig. 4). Early symptoms on these parts appear as water-soaked depressions; and later, a white moldy growth may develop.

In years when the berries are attacked by downy mildew, there can be two periods of infection during one growing season. The first is in June, when the berries are about the size of small peas. When the berries are infected at this period, they become soft, shatter easily, and frequently are covered with a white downy growth (fig. 5). During the hot part of summer there is less evidence of mildew rot, but when nights become cooler, the second period of infection may occur. Berries infected at this time



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FIGURE 4.—Tips of grapevine killed by downy mildew.



PN-6328

FIGURE 5.—Downy mildew on young grape berries. (Courtesy Department of Plant Pathology, Cornell University.)

generally do not soften or show the downy growth; instead, they become brownish, wither, and shatter easily.

Downy mildew of grapes is comparatively easy to control in most areas and on most varieties. The fungicides listed for black rot are generally effective against early season infections of downy mildew.

From midseason on, downy mildew increases in importance and black rot becomes less important. Ferbam is not as effective against downy mildew as zineb, captan, fixed copper-lime, or bordeaux mixture (4-4-100). Therefore, these materials are preferred for midseason disease control. Bordeaux mixture leaves a conspicuous residue on the fruit, so it is not used for late season sprays when fruit is for fresh market.

Anthracnose or Bird's-Eye Rot

Anthracnose, a fungus disease, occurs in some sections of the Northeastern and Southeastern States, but it usually is localized and confined to a few varieties. The disease can do considerable damage in a vineyard or a locality for a few years—and then disappear.

Anthracnose is seldom severe on Concord in areas where this disease is found. Most bunch grape varieties are resistant, but a few such as Campbell Early, Catawba, Champion, Diamond, Noah, and Norton (Cynthiana) and some French hybrids such as Seibel 1000 and Seibel 4986 are susceptible.

The effect of the disease on the berries and other parts of the vine is rather striking. This disease is not easily confused with other grape diseases. The berries, young shoots, tendrils, petioles, leaf veins, and fruit stems may be attacked severely.

Numerous spots sometimes occur on the young shoots. Some of these spots combine and cause girdling, which kills the vine tips. Similar spots develop on the petioles and leaves, especially on the undersides of leaves. Badly infected leaves curl downward and become spotted. The spotted tissues eventually drop out.

Spots on the berries are circular, sunken, and ashy gray. In the late stages of the disease the spots have a dark border. The name "bird's-eye rot," sometimes applied to this disease, is derived from the appearance of the spots on the berries (fig. 6).

Ripe Rot and Bitter Rot

There are two fungus rots of berries which may appear as the fruit begins to mature. Both are more prevalent in the South and will be more severe during a wet season or if there has not been a careful spray program to control black rot. Both rots cause a bitter, off-flavor of the fruit.

Bitter rot generally enters the berry through an infection of the cluster stem, so the first symptom on a nearly mature berry is a discoloration of the berry around the point of attachment. As the rot spreads



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FIGURE 6.—Severe anthracnose on a cluster of grapes showing typical lesions on the stem. Inset shows symptoms of anthracnose on a single berry.

through the berry, numerous elevated pustules form which resemble black rot. The pustules are irregular in shape and size and rupture the cuticle of the berry. Spores are dark and may give a sooty appearance to the infected berries. The fungus is sometimes found on old leaves after harvest.

The bitter rot fungus may infect green berries if they have been injured but generally appears about the time of ripening.

Nearly mature berries may shrivel and remain attached. Fully mature berries usually soften slightly and shell off. These berries have an unpleasant burnt-bitter taste.

Ripe rot is less common than bitter rot, although under humid conditions it can be destructive. Infected berries may be shrunk, but generally fall off before they dry. Infected areas of a berry may show concentric zones. Spores, when they accumulate, are pinkish and shiny when wet.

The regular sprays for black rot and downy mildew generally control both these diseases.

Dead Arm

Dead arm, a fungus disease, occurs throughout the Northeastern States, where it attacks the trunk and main branches of the vines, primarily. Although it can also attack young canes and leaves, damage to these parts of the plant is less severe.

Entering the trunk and main branches through wounds caused by pruning or winter injury, the fungus lives in the woody tissues as a perennial parasite. There it infects and kills tissues, causing a canker to form. The canker enlarges each year until it finally girdles the trunk or main branches. Girdling kills the part of the vine above the canker. And although a new shoot may develop near the canker, it usually is weak and has yellowed and cupped leaves. It generally dies the following winter.

Symptoms on the canes and leaves first appear as small dark spots. As the canes grow, the spotted tissues may split. These symptoms appear in early spring and, although not economically important, indicate that dead arm is present in the vineyard and that specific control measures should be taken to protect the vines.

To control dead arm, cut off the diseased parts below the canker. Remove the cuttings from the vineyard and burn them.

A delayed dormant spray of bordeaux mixture (8:8:100) will protect against dead arm. Or use two sprays of captan. Prepare the captan spray by mixing 4 pounds of captan to 100 gallons of water. Apply it at 50 gallons per acre when new shoots are 1 to 2 inches long and again when the shoots are 4 to 6 inches long.

Powdery Mildew

Powdery mildew is a fungus disease that occurs in many vineyards, but it is of little economic importance in the Eastern States on most bunch grape varieties such as Concord. However, on some varieties such as Seneca, Interlaken, and many of the French hybrids which have more vinifera in their lineage, powdery mildew can result in severe losses if not controlled.

East of the Mississippi River, powdery mildew is largely a disease of the foliage and cluster stems. It appears as a white, powdery growth on the leaves and other green parts of the vine

(fig. 7). Severely affected leaves turn brown and fall. Loss of effective foliage may result in poor wood maturity, and vines will be more subject to winter damage. If the berries are infected, they appear rusty or scaly. They fail to mature properly and may split. Infected cluster stem may become brittle and break during harvest, causing loss of ripe fruit.

On varieties that are moderately susceptible to powdery mildew, the use of folpet or fungicides containing copper will help control this disease.

On very susceptible varieties special sprays may be necessary. Two or three sprays of benomyl (1/2 lb per acre) or sulfur (5 to 10 lb per acre) before bloom, just after bloom, and about 4 weeks later if the disease is still present, are generally recommended. However, sulfur will

cause severe leaf damage on some varieties such as Concord, Foch, Ives, and Seibel 5898.

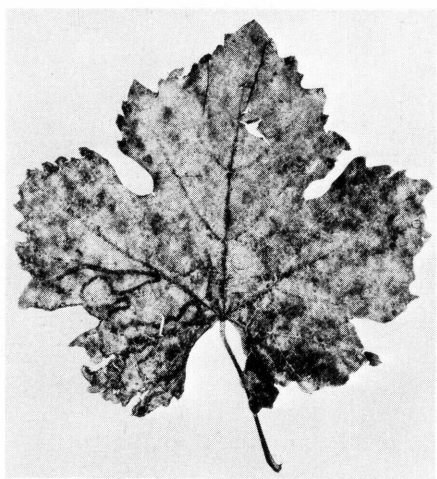
A lime-sulfur spray (2 qt of 30-percent solution per 100 gal) when new shoots are 4 to 6 inches long will also help control powdery mildew.

Root and Trunk Diseases

The roots of grapes are attacked by several organisms that cause swellings or decay. Root diseases are not easily detected. It is often necessary to remove a plant or part of the root system from the soil to examine it for suspected root diseases. In general, the symptoms of root diseases are: slow growth of the vine, low productivity, small, scant, yellowish leaves, and wilting.

To prevent root diseases, plant vines that have disease-resistant root stocks. Ask your county agricultural agent or State agricultural experiment station specialist for advice on choice of rootstocks.

Crown Gall.—Although not usually a serious grape disease in the Eastern States, crown gall is conspicuous on lower trunks and canes when it occurs. It is caused by a bacterium that enters wounds of roots or trunks. Pruning cuts made when basal sprouts are removed, or when winter injury causes splitting of trunks and canes, provide the usual entry routes of this organism. A wound callus may develop along the splits on cold-injured vines that look like crown



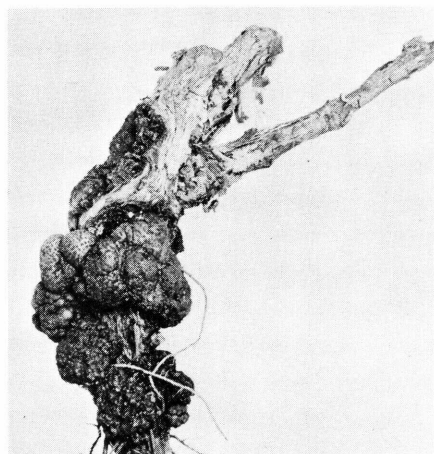
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FIGURE 7.—Powdery mildew on upper side of grape leaf.

gall. Infected roots develop large spherical galls, usually near the ground line. Sometimes they become as large as walnuts (fig. 8). The crown gall organism is widely distributed and attacks various fruit trees and shrubs.

Because this organism lives in the soil, it cannot be controlled by spraying. When galls are confined to the branches or trunk, remove all affected tissue; make cuts at least 2 inches below the gall. Examine new plants before planting, and discard any that have galls.

If crown gall is a recurring or persistent problem on lower trunks, vines can be trained to multiple trunks, generally three. When one becomes severely affected with galling, a replacement sucker from ground level is retained and the diseased trunk removed.



PN-6331

FIGURE 8.—Crown gall on grape root on surface of soil.

Pierce's Disease

This bacterial disease is spread by several species of sharpshooters, or large leafhoppers. It is widespread throughout the Southeastern States. Much of the degeneration in American bunch grape plantings in these States is attributed to Pierce's disease.

Muscadine grapes and the varieties Lake Emerald, Blue Lake, and Stover, are very tolerant of the disease. Older American varieties that are tolerant of Pierce's disease include Champanel, Herbemont, and Lenoir.

Symptoms of this disease differ widely, depending on the season and the variety. They include (1) delayed foliation, (2) dwarfing of shoots, (3) marginal dying of leaf tissue, (4) wilting or premature coloring of fruit, (5) uneven maturity of canes, and (6) gradual dying of root system and degeneration of vine.

Pierce's disease causes obvious damage only in the Gulf States. Once a vine is infected, there is no cure. However, damage from this disease can be prevented or reduced by using varieties that are tolerant of the disease and adapted to the area.

Virus Diseases

Several virus diseases occur on grapes. They affect only certain varieties—particularly those with considerable vinifera parentage—and may not produce obvious symptoms. Among the symptoms are premature scorch-

ing of leaves in the fall, delayed maturity of fruit, reduced sugar content of fruit, and general reduction in vigor and productivity of vines.

Once a vine is infected with a

virus, there is no cure. Propagations from such a vine will carry the virus. Select only the most productive vines for propagation. Virus-indexed vines of many varieties are available.

DISEASES OF MUSCADINE GRAPES

Muscadine grapes are adapted to the Southeastern States. In general, they are less severely injured by diseases than are the bunch grapes. The home fruit grower can usually supply his own needs from a vine or two without using any pesticide sprays. The commercial grower will find that yields are markedly increased when a spray program is used to control diseases and insects. Specific spray recommendations vary, so the commercial grower should ask the advice of his county agricultural agent or state agricultural experiment station.

Black Rot

The fruit of such muscadine varieties as Hunt, James, Mish, Scuppernong, and Thomas is relatively free of diseases. Black rot, the most damaging fruit disease of American bunch varieties, causes minor damage to the fruit of muscadine varieties. Although infection by black rot does not cause decay on muscadines, it results in a black, shallow, scablike defect (fig. 9).

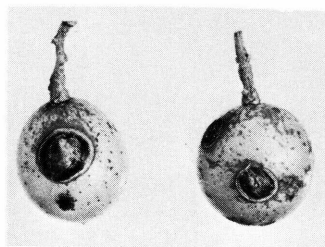
However, the blossoms are susceptible to black rot. A few days of cloudy, rainy weather during the blossoming period will favor

infection and sometimes will result in a heavy drop of blossoms. Black rot causes heavy spotting on the leaves of muscadine grapes. In seasons favorable for the fungus, the spots are rather conspicuous and numerous, and a large part of the leaf usually is destroyed (fig. 10). The leaves of Mish and Scuppernong are very susceptible to this disease.

Spraying to control black rot on muscadine grapes is not profitable, except during an unusually wet season.

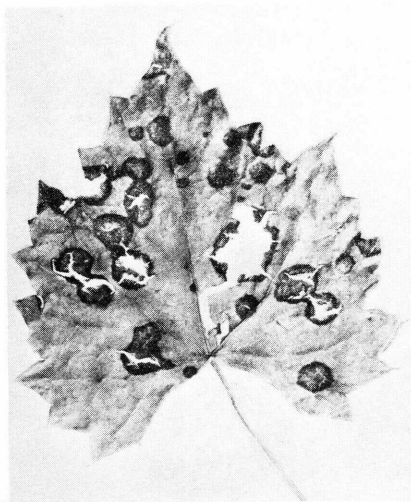
Bitter Rot

Bitter rot, a fungus disease, is the major cause of muscadine fruit loss between the time of fruit set and harvest. Berries infected with bitter rot decay and shatter. (Some varieties of mus-



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FIGURE 9.—Effect of black rot on muscadine grapes.



PN-6333

FIGURE 10.—Spots caused by black rot fungus on leaf of muscadine grape.

cadines may shatter whether this disease is present or not.) On certain varieties, such as Topsail, the fungus may spot or fleck the leaves, as well as affect the berries.

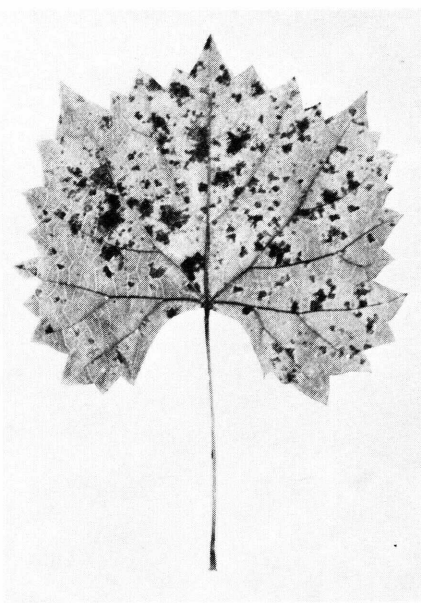
In vineyards where bitter rot is severe, apply fungicide 1 month and again 2 weeks before harvest.

Cercospora, or Angular, Leaf Spot

Cercospora, or angular, leaf spot is a fungus disease. It is the most economically important disease affecting the leaves of muscadine grapes. All commonly grown varieties are susceptible, although Flowers, Scuppernong, and Thomas are more resistant than Creek, Howard, Hunt, and Stuckey. The leaf spot fungus does not attack the berries.

Infected leaves first show irregular, brown spots. The tissues surrounding the spots turn yellow. The spots enlarge and combine (fig. 11). Severe infection on the more susceptible varieties results in defoliation and impaired quality of the berries.

The disease can be easily controlled by applying a fungicide at 2- to 3-week intervals during the first half of the growing season. This treatment is necessary, however, only when the disease has become established in a vineyard. Because the spores over-winter on old fallen leaves, remove or plow under the leaves before new spring foliage appears.



PN-6334

FIGURE 11.—Muscadine grape leaf spotted by *Cercospora*.

INSECTS AND OTHER PESTS

Grape Berry Moth

Grapes are frequently damaged by larvae of the grape berry moth.³ The larvae are active greenish caterpillars about three-eighths inch long when full grown.

First-brood larvae feed in the blossoms or very young fruit clusters and in the newly formed berries. Larvae of later broods damage both the green and ripening berries (fig. 12, A), and often cause serious losses. One larva can injure several berries.

After feeding on the berries, the caterpillar cuts a small bit of leaf, folds it over, and constructs a cocoon within the fold (fig. 12, B). The leaf folds containing the cocoons may remain attached to the leaves or they may break off and fall to the ground. Caterpillars of the first brood usually construct their cocoons on leaves that are on the vine during June or July. Those of the second brood usually drop to the ground and form their cocoons on small pieces of leaves under the grape trellis (fig. 12, C).

This insect overwinters in the cocoon (fig. 12, D). In late spring or early summer the inconspicuous brownish moths (fig. 12, E) emerge and lay their eggs on the grape stems or berries.

The grape berry moth is found throughout most of the Eastern

States and is particularly troublesome in the region north of the Ohio River, east of the Mississippi River, and on through New England.

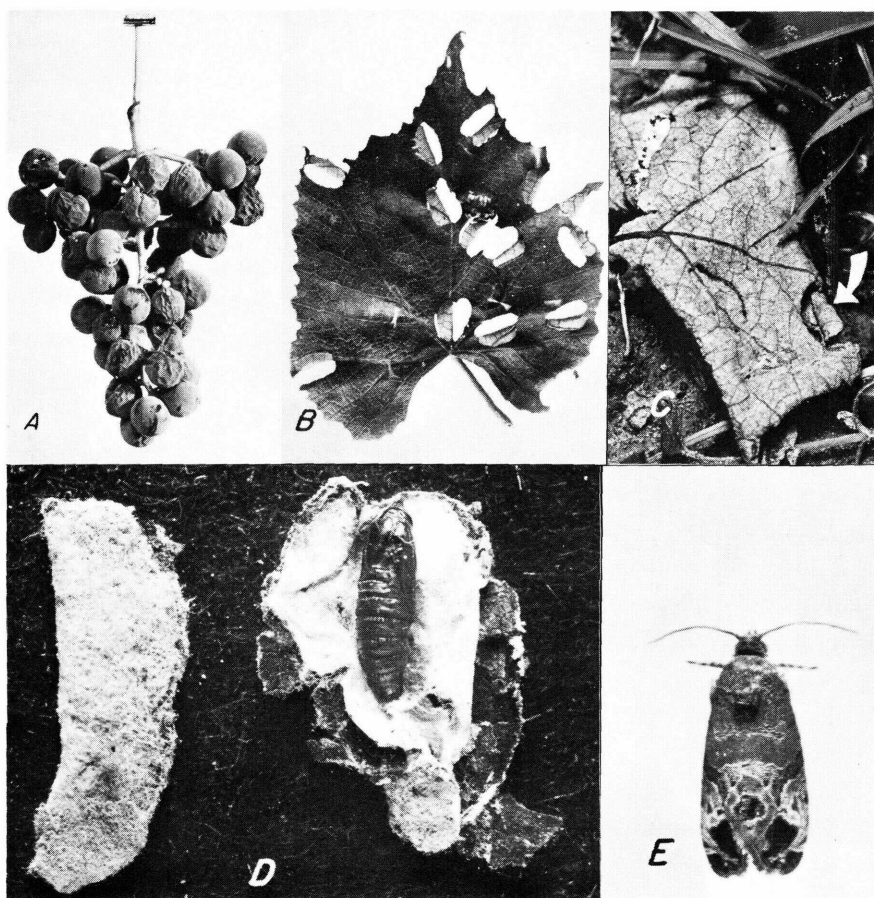
The grape berry moth may be controlled by using cultural methods. In general these methods include using tillage implements to bury overwintering cocoons under a layer of soil. The moths are unable to make their way out in the spring and they die.

Insecticides may also be used for control of the grape berry moth. Those insecticides recommended for control are methoxychlor, carbaryl, parathion, or azinphosmethyl. For protection against the grape berry moth, one of these insecticides should be applied 3 to 5 days before bloom, immediately after bloom, and 55 to 60 days after bloom. For application rates and minimum days from last application to harvest, see the table on p. 28.

Grape Leafhoppers

Grape leafhoppers, *Erythro-neura comes* and related forms (fig. 13, A and B), are often abundant during the summer on the undersides of grape leaves. These small, jumping insects are white or pale yellow and have red or yellow markings. They suck juice from the leaves and cause white blotches (fig. 13, C) that later change to brown. As a result, many leaves fall from the vines prematurely.

³ For the scientific names of insects mentioned in this bulletin, see p. 34.



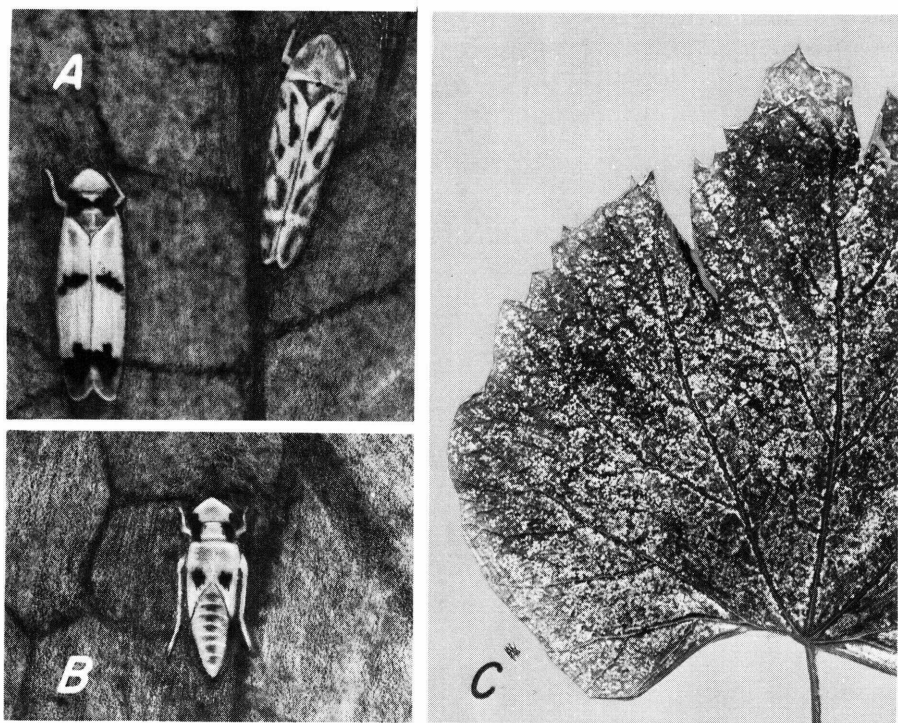
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FIGURE 12.—A, Cluster of grapes injured by grape berry moth; B, cocoons of moths on fallen grape leaf (cocoons are hidden under small flap of cut and folded leaf material); C, overwintering cocoon of grape berry moth (indicated by arrow) on ground under trellis; D, cocoon and pupa within an opened cocoon (about four times natural size); E, adult (about 4-1/2 times natural size).

This damage prevents normal vine growth and interferes with proper ripening of the fruit.

The insects overwinter as adults in protected places, usually in trash in or near vineyards. In early spring, the

leafhoppers become active and feed on any green vegetation they can find. They are most abundant, however, on new grape leaves. There are two or three generations of these insects each season.



PN-6340

FIGURE 13.—A, Adult grape leafhoppers; B, nearly full-grown nymph; C, mottled grape foliage injured by grape leafhoppers. Insects about 10 times natural size.

Grape leafhoppers can be controlled with methoxychlor, malathion, or endosulfan (see p. 28 for dosages and minimum waiting period from last application to harvest). To protect grapes from leafhopper injury, the insecticides should be applied immediately after bloom and 10 to 15 days later.

Grape Rootworm

The grape rootworm (larva) infests and damages the roots of grapevines (fig. 14, A).

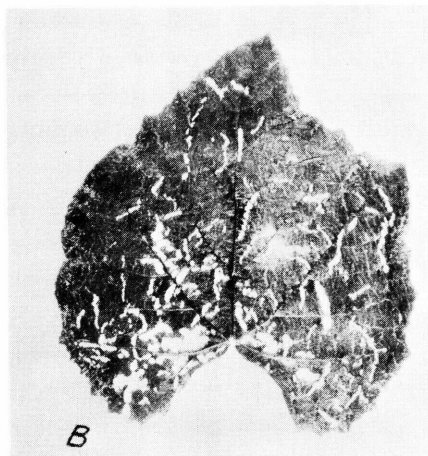
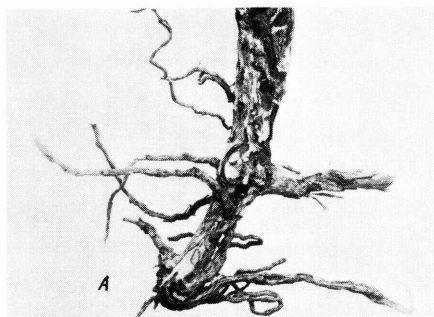
The adult—a small, hairy, chestnut-brown beetle—appears

in vineyards of such varieties as Catawba, Concord, and Niagara shortly after the blooming period. It feeds on the leaves and makes chainlike patches or holes in them. Leaf damage is not important, however, compared to the larva's damage to the roots.

This insect has not been a problem in vineyards where sprays have been applied to control the grape berry moths.

Rose Chafer

In some localities in the Eastern States the rose chafer (fig.



PN-6341 PN-6342

FIGURE 14.—A, Injury by larvae of grape rootworm to roots of grapevine; B, feeding marks by adults on grape leaf.

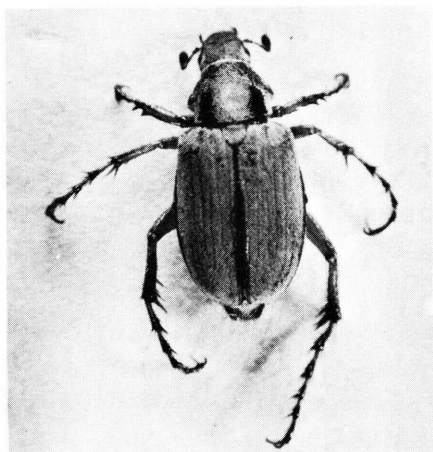
15) causes severe damage early in the season to grape leaves, blossoms, and newly set berries. The beetles are general feeders; they damage many kinds of fruits and ornamental plants. They sometimes fly into a vineyard in large numbers and consume most of the foliage. Their feeding period lasts from 3 to 4 weeks.

This insect breeds largely in lawns and pastures. In its larval stage it is a small white grub.

For effective control of the rose chafer, apply a spray that contains methoxychlor. Spray as soon as the beetles appear; they can do considerable damage in a 24-hour period. Sometimes it may be necessary to spray while the grapes are in bloom. More often, a spray to control the rose chafer will be needed near the time of the first spray to control the grape berry moth. If so, a single application is enough for both insects. A fungicide (p. 28) may be added to this spray for disease control.

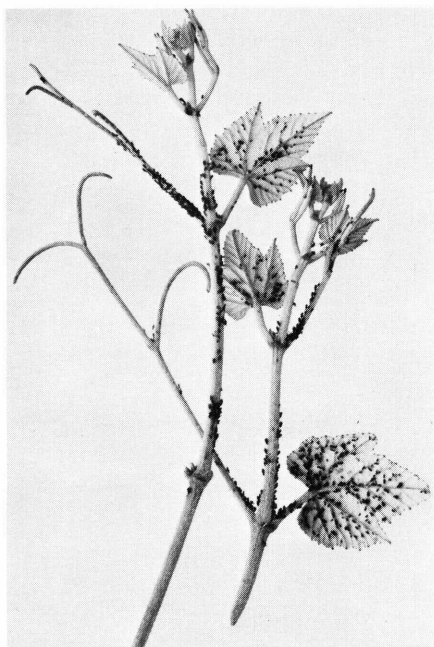
Grapevine Aphid

In vineyards east of the Mississippi River, grapevine aphids are often found in large numbers during the summer on the young shoots and leaves (fig. 16). This tiny dark-brown aphid is most likely to appear in dry weather and often disappears



PN-6343

FIGURE 15.—Adult female rose chafer. About two times natural size.



PN-6344

FIGURE 16.—Grapevine aphids on grape shoots and young leaves.

almost completely after a heavy rain. When the aphids are abundant, they may infest the fruit clusters and cause some of the grapes to drop. In fall, the aphids leave the grapevines and migrate to the blackhaw, where they spend the winter and spring; they return to the grapevines in early summer.

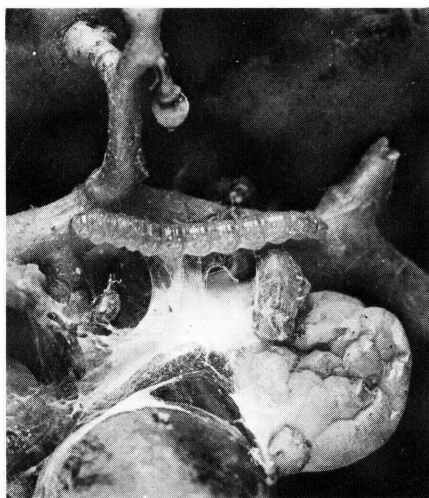
To control the grapevine aphid, spray the vines with parathion or malathion after the aphids appear. This may require application of a special spray but, if timing is convenient, one of these materials may be added to a spray in the general schedule. (See p. 29 for dosages.)

Redbanded Leafroller

Grapes may be damaged by larvae of the redbanded leafroller throughout the Eastern States. It is a greenish caterpillar about three-quarters inch long when full grown. The caterpillar spins webbing in grape clusters and feeds on the berries while protected by the web (fig. 17). The first brood of caterpillars can appear as early as April, and there usually are two or three broods each year.

Sprays applied just before or after grape bloom reduce damage caused by later broods without leaving excessive harmful residues on the berries.

Parathion or carbaryl at the dosage recommended in the table on p. 28 will control the redbanded leafroller. The spray applications should be made just



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FIGURE 17.—Larva of redbanded leafroller on grape stem. About two times natural size.

before bloom or at petal fall for protection of the grapes against damage by the redbanded leaf-roller.

Grape Flea Beetle

The grape flea beetle adult is dark blue, shiny, and about three-sixteenths inch long (fig. 18). This insect overwinters as an adult in debris in or near vineyards in two-thirds of the Eastern States.

Early in spring, just as grape buds are swelling, it migrates to the grapevines and kills the buds by eating out their centers. As the secondary grape shoots develop, it lays eggs, and the worms (about one-fourth inch long when full grown) feed on the upper surface of the grape leaves.

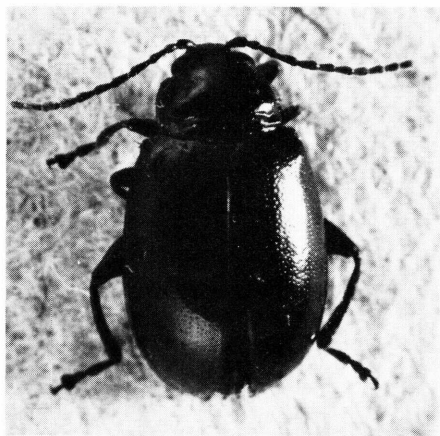
This insect usually occurs in localized areas within a vineyard, particularly near woods or buildings. Its damage to grape

buds closely resembles that caused by climbing cutworms. Be sure to determine which insect is causing the damage.

This insect has not usually been a problem in vineyards where sprays have been applied to control the grape berry moth.

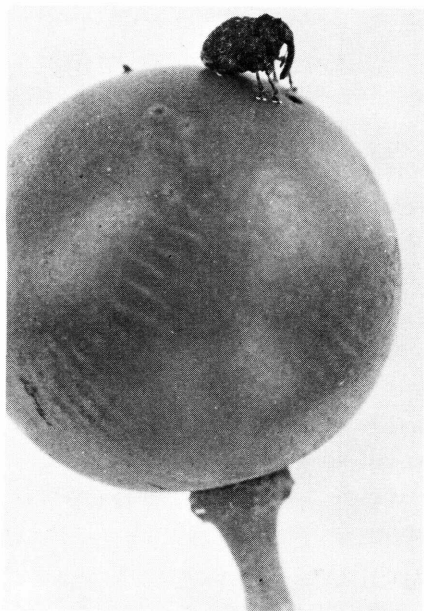
Grape Curculio

The grape curculio occurs from New England to Florida and west to the Mississippi Valley, but it is more prevalent and destructive in Ohio, West Virginia, and west to Illinois and Arkansas. The adult (fig. 19) is a broad, dark-brown snout beetle about one-tenth of an inch long. It feeds on the leaves of wild and cultivated



PN-6346

FIGURE 18.—Adult grape flea beetle. About 10 times natural size.



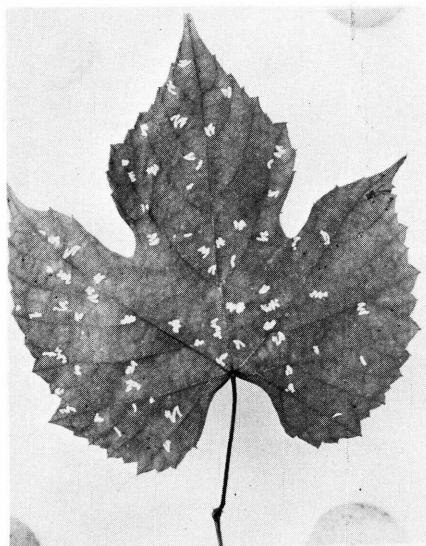
PN-6347

FIGURE 19.—Adult grape curculio resting on grape near partially completed egg chamber.

grapes. The larva feeds on the flesh and seeds of the berries.

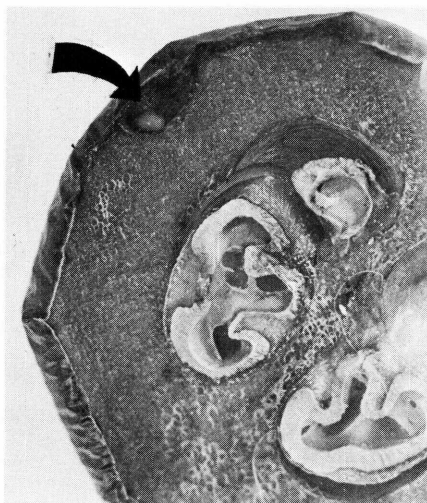
The adult hibernates in or near vineyards, particularly along the edge of woodlands. It becomes active in the spring—about the time the Concord is in bloom—and feeds on the leaves from 10 to 14 days before laying eggs. The damage appears as short, curved lines, usually in groups (fig. 20).

The eggs are placed in small shallow cavities that the adult cuts into the berries during July and August (fig. 21). They hatch in about 6 days. The larva develops inside the berries and feeds on the flesh and seeds for about 3 weeks. When mature, it leaves the berries and constructs a small earthen cocoon, from which the adult beetle emerges in 3 or 4 weeks. After emerging, the adult feeds on



PN-6348

FIGURE 20.—Feeding marks on grape leaf made by grape curculio.



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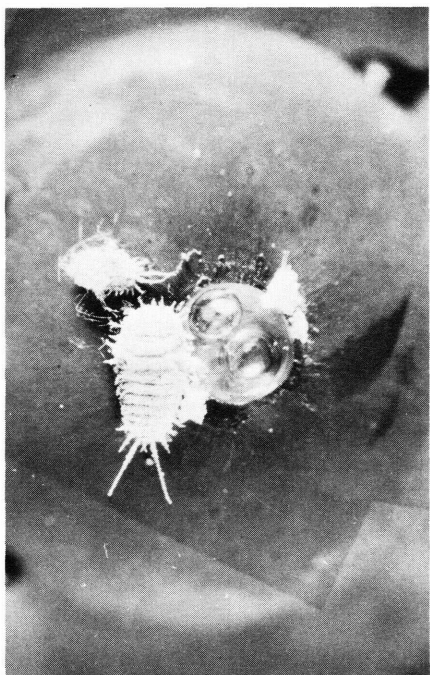
FIGURE 21.—Egg and egg chamber of grape curculio.

grape leaves until cold weather when it goes into hibernation.

Grape curculio is not normally a problem when a program for control of the grape berry moth is followed.

Grape Mealybug

The grape mealybug is a whitish insect that sucks juice from the canes, stems, and berries of grapevines (fig. 22). There are two broods each year. The eggs are laid in early fall in a cottony mass under the loose bark of the grape trunk. The eggs hatch in late fall, but the young mealybugs do not leave the trunk until early spring. They then crawl out from under the bark and up onto the developing grape buds and shoots. These insects mature in early summer, and a second brood is started. It



PN-6350

FIGURE 22.—Grape mealybug (immature) feeding at junction of pedicle and grape berry. About seven times natural size.

feeds mainly on the grape clusters.

Mealybugs secrete a sweetish honeydew fluid (fig. 23) in which a sooty mold develops. It gives the grapes an objectionable appearance and flavor. Damage by mealybugs also causes the cluster stems and berries to shrivel and fall.

To control the grape mealybug, apply parathion or malathion just before or after bloom and repeat in 10 days if needed using the dosages given on p. 29. Do not spray when mealybugs are under the bark of the grape trunk.

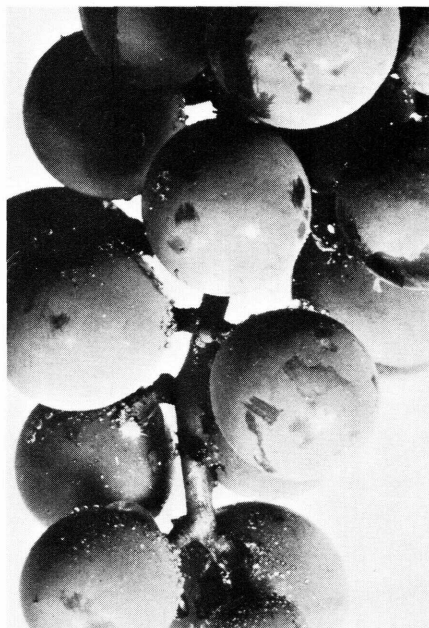
Japanese Beetle

The Japanese beetle (fig. 24, A) is about one-half inch long. It is shiny metallic green and has coppery-brown wing covers. It appears on grapes early in the summer—about June 1 in parts of Virginia, June 15 near Philadelphia, and July 1 or later in New England.

For 4 to 6 weeks the beetles feed heavily on grape leaves (fig. 24, B), particularly those directly exposed to the sun, giving them a lacelike appearance. Badly damaged leaves fall.

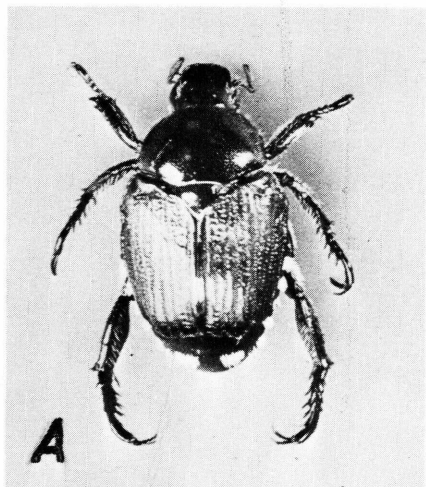
The eggs are laid in the soil, most commonly in grassy areas, where the grubs develop.

To control the Japanese beetle



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FIGURE 23.—Honeydew secretion on grape berries caused by feeding of grape mealybugs. About two times natural size.



PN-6352 PN-6353

FIGURE 24.—Japanese beetle: A, Adult, enlarged; B, beetles feeding on grape leaf.

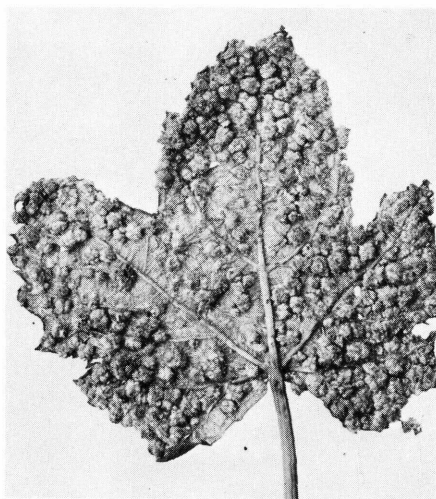
on grapes, apply carbaryl, methoxychlor, malathion, or parathion at the dosages given on p. 29 when the adults appear.

Wild grapes in the Eastern States and varieties developed from them differ in their immunity to gall injury and thrive in spite of it.

Gall Makers

Swellings, or galls, of various kinds occur on grapes as a result of attack by several unrelated insects. Gall insects appear early in the season, sometimes 3 or 4 weeks before grape bloom. Most of them have several broods during the season. The infestations are limited to small areas in a vineyard, and damage to the vines or crop is not often serious.

Leaves covered with galls (fig. 25) may indicate an infestation by the grape phylloxera, a small aphidlike insect that attacks both roots and foliage. Root damage is particularly serious on vinifera varieties of grapes.



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FIGURE 25.—Leaf galls of grape phylloxera.

To control leaf infestations of phylloxera, apply lindane when the galls first appear and again 7 to 10 days later. See page 29 for dosage. Chemical procedures for control of the root-infesting forms have not proved satisfactory.

The term "tomato gall" is used to describe masses of irregular succulent galls often found on wild and cultivated grapes (figs. 26 and 27). They are caused by *Lasioptera vitis*, *Dasineura vitis*, and other species. The galls may be on the leaves, leafstalks, tendrils, or stalks of the fruit clusters and are greenish yellow to reddish. They are divided into tiny cells, in each of which an orange-yellow larva, or grub, develops. The

adults are tiny flylike insects known as gnats, or midges. They appear in the spring in time to attack new, tender growth.

Pear-shaped, hazelnutlike galls (fig. 28), which are less than an inch in diameter, first greenish and then reddish as the season advances, are caused by the grape apple gall maker. These galls have exterior depressions extending lengthwise, which are divided into cells in which the bright-yellow larvae develop.

An enlargement on the cane—usually just above a lower joint, about twice the diameter of the cane, and 1 or 2 inches long—may result from a puncture by the grape cane gall maker, a small reddish-brown weevil. An egg is placed in this

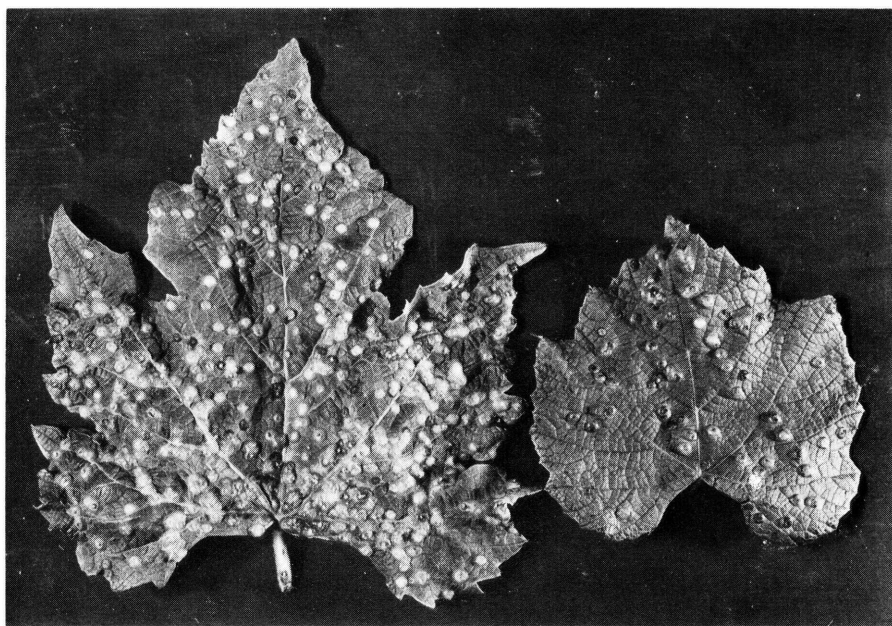


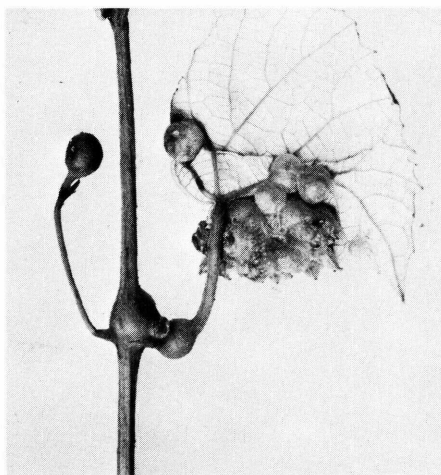
FIGURE 26.—Grapevine tomato galls on grape leaves.

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puncture, and several additional punctures may be made above the original one, but no additional eggs are deposited. The larva feeds in the pith, burrowing up and down the shoot. The beetle emerges in midsummer. The injured canes continue to grow and become enlarged at the puncture, but unless they are broken, little harm results.

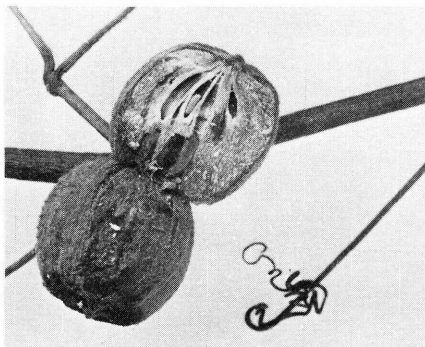
Grape leaves sometimes are covered with slender galls, which are about one-third inch long and reddish to green. These trumpet, or grape tube, galls are caused by a small midge, or gnat, known as *Cecidomyia viticola*. The larva, or grub, within the gall is pale orange.

Growers of vinifera grapes should plant vines that are on phylloxera-resistant rootstocks. Growers of American varieties will seldom find the grape phyl-



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FIGURE 27.—Grapevine tomato galls on grape leaf and tendril.



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FIGURE 28.—Grape apple galls.

loxera of sufficient economic importance to require control measures.

Bees, Wasps, and Birds

Bees and wasps attack grapes through injuries caused by other insects, birds, and by diseases, or through splits in the skins of overripe berries. Bees and wasps are not able to break the skin of sound grapes with their mouth parts. When the skin has been broken, however, they can quickly make the fruit worthless.

To prevent damage by bees and wasps, control other insects and diseases that injure the skin of grapes. Pick grapes before they are overripe.

During seasons when grapes mature and ripen early, small migrating birds may peck tiny holes in the grapes. Bees, wasps, pomace flies, and bacteria then can spoil the fruit. Large birds, such as starlings, robins, crows, and sparrows, eat most of the grapes and leave practically nothing to spoil.

SPRAY SCHEDULE FOR GRAPES

Because of differences in growing season, climate, and distribution of diseases and insects, this bulletin does not attempt to present a general spray schedule. Most State agricultural experiment stations have specific spray schedules for grapes which reflect the local needs and possible intrastate restrictions on certain pes-

ticides. Such spray schedules or advice can be obtained through your county agricultural agent.

The advantage of early sprays is emphasized. Infection of leaves and canes must be prevented if clean fruit is to be produced. Little good can be accomplished if spraying is postponed until the fruit begins to rot or insect damage appears.

USE OF PESTICIDES

This publication is intended for nationwide distribution. Pesticides are registered by the Environmental Protection Agency (EPA) for countrywide use unless otherwise indicated on the label.

This use of pesticides is governed by the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended. This act is administered by EPA. According to the provisions of the act, "It shall be unlawful for any person to use any registered pesticide in a manner inconsistent with its labeling." (Section 12(a) (2) (G))

EPA has interpreted this section of the act to require that the intended use of the pesticide must be on the label of the pesticide being used or covered by a Pesticide Enforcement Policy Statement (PEPS) issued by EPA.

The optimum use of pesticides, both as to rate and frequency, may vary in different sections of the country. Users of this publication may also wish to consult

their Cooperative Extension Service, State agricultural experiment stations, or county extension agents for information applicable to their localities.

The pesticides mentioned in this publication are available in several different formulations that contain varying amounts of active ingredient. Because of these differences, the rates given in this publication refer to the amount of active ingredient, unless otherwise indicated. Users are reminded to convert the rate in the publication to the strength of the pesticide actually being used. For example, 1 pound of active ingredient equals 2 pounds of a 50-percent formulation.

The user is cautioned to read and follow all directions and precautions given on the label of the pesticide formulation being used.

Federal and State regulations require registration numbers. Use only pesticides that carry one of these registration numbers.

USDA publications that contain suggestions for the use of pesticides are normally revised at 2-year intervals. If your copy is more than 2 years old, contact your Cooperative Extension Service to determine the latest pesticide recommendations.

The pesticides mentioned in this publication were federally registered for the use indicated as of the issue of this publication. The user is cautioned to determine the directions on the label or labeling prior to use of the pesticide.

SPECIAL PRECAUTIONS

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

Do not use endosulfan on Concord grapes; it can severely injure them. Malathion emulsifiable concentrate may injure some vinifera varieties if applied after clusters appear, but malathion wettable powder may not.

Parathion and azinphosmethyl are highly toxic and may

cause death if swallowed, inhaled, or absorbed through your skin. These insecticides should be applied only by persons who are thoroughly familiar with their hazards and who will assume full responsibility for their safe use and comply with all precautions on the container labels.

Endosulfan and lindane, although less toxic than parathion and azinphosmethyl, can be absorbed through the skin in harmful amounts. Follow precautions on the label carefully when using these insecticides.

Methoxychlor, malathion, carbaryl, and all of the fungicides mentioned in this publication are among the less hazardous pesticides to handle, as long as label directions are followed and safe handling procedures are used.

Mention of a proprietary product in this publication does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture to the exclusion of other products that may also be suitable.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment

or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

Pesticides for control of diseases and insects of grapes

INSECT	PESTICIDE	TOLER- ANCE (p/m)	MIN. DAYS FROM LAST APPLI- CATION TO HAR- VEST OR FEED- ING	FORMU- LATION	POUNDS OF ACTIVE INGREDIENT TO APPLY UNLESS OTHERWISE INDICATED		WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
					PER 100 GAL.	PER ACRE		
Grape berry moth (<i>Paralobesia viteana</i>)	Azinphosmethyl	5	0	WP	0.25	0.75	At petal fall, 7-14 days later, when second-brood eggs are found (35-45 days after bloom), and 14 days after bloom), and 14 later.	Do not use <i>azinphosmethyl</i> or <i>parathion</i> in home plantings; should be applied only by a trained operator. <i>Malathion</i> EC may injure the Ribier, Italia, Cardinal and Almeria varieties if applied after clusters appear.
	Carbaryl	10	0	WP	1	3		
	Diazinon	0.75	10	WP	0.3	1		
	Methoxychlor	14	14	WP	1	3		
	Methoxychlor + parathion	14 + 1	14	WP + WP	1 + 0.15	3 + 0.5		
Grape leaf folder (<i>Desmia funeralis</i>)	Parathion	1	14	WP	0.22	0.7	When adults or small larvae appear. Schedule for grape berry moth gives control.	Limit use of <i>azinphos- methyl</i> to 3 applications per season.
	Parathion + carbaryl	1 + 10	14	WP + WP	0.15 + 1	0.5 + 3		
	Parathion	1	14	WP	.25	1		
Grape leafhopper (<i>Erythroneura comes</i>)	Endosulfan	2	7	WP	0.5	1.5	When leafhoppers appear.	<i>Endosulfan</i> may cause severe injury to Concord variety. <i>Malathion</i> EC may injure the Ribier, Italia, Cardinal, and Almeria varieties if applied after clusters appear.
	Malathion	8	3	EC or WP	0.9	2.75		
	Methoxychlor	14	14	WP	1	3		

Grape mealybug (<i>Pseudococcus maritimus</i>)	Malathion	8	3	EC	0.9	2.75	When overwintered nymphs move out from under bark to base of buds or onto grape clusters (just before or after bloom); repeat in 10 days if needed.	Do not use <i>lindane</i> later than 1 month after bloom.
	Parathion	1	14	WP	0.3	1		
<hr/>								
Grape phylloxera (leaf form only) (<i>Phylloxera vitiifoliae</i>)	Lindane	10	—	WP	0.3	1	When galls first appear on leaves; repeat in 7–10 days.	
<hr/>								
Grapevine aphid (<i>Aphis ilinoensis</i>)	Malathion	8	3	EC or WP	0.9	2.75	When aphids appear on shoots.	Do not use <i>parathion</i> in small home plantings; be applied only by a trained operator.
	Parathion	1	14	WP	0.15	0.5		
<hr/>								
Japanese beetle (<i>Popillia japonica</i>)	Carbaryl	10	0	WP	2	3	When beetles appear; re- peat 10–14 days later if needed.	Do not apply <i>tetradifon</i> more than 3 times during fruiting period.
	Methoxychlor	14	14	EC or WP	1.5	4.5		
	Malathion	8	3	EC or WP	0.9	2.75		
	Parathion	1	14	WP	0.3	1		
	Rotenone	Exempt	1	Powder	0.12	0.5		
	<hr/>							
Redbanded leafroller (<i>Argyrotaenia velutinana</i>)	Carbaryl	10	0	WP	2	3	Just before bloom or at petal fall and for early stages of first and second broods.	Do not use <i>parathion</i> in home plantings; should be applied only by a trained operator.
	Parathion	1	14	WP	0.3	1		
<hr/>								
Rose chafer (<i>Macrodactylus subspinosus</i>)	Methoxychlor	14	14	WP	1	3	When adults first appear, usually near bloom of Concord grapes.	<i>Malathion</i> EC may injure the Ribier, Italia, Cardinal, and Almeria varieties if applied after clusters appear.

Do not use *lindane* later than 1 month after bloom.

Do not use *parathion* in small home plantings; be applied only by a trained operator.

Do not apply *tetrathion* more than 3 times during fruiting period.

Do not use *parathion* in home plantings; should be applied only by a trained operator.

Malathion EC may injure the Ribier, Italia, Cardinal, and Almeria varieties if applied after clusters appear.

Pesticides for control of diseases and insects of grapes—Continued

INSECT	PESTICIDE	TOLER- ANCE (p/m)	MIN. DAYS FROM LAST APPLI- CATION TO HAR- VEST OR FEED- ING	FORMU- LATION	POUNDS OF ACTIVE INGREDIENT TO ACRE, UNLESS OTHERWISE INDICATED		WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
					PER 100 GAL	PER ACRE		
Black rot (<i>Guignardia bidwellii</i>)	Captan	50	NTL	WP or D	1	1.1-2.1	Make two applications before blossoming and 3 or 4 applications at 10- 15 day intervals after bloom.	
	Ferbam	7	7	WP or D	0.76-1.52	1.7-2.9	Apply just before bloom, just after bloom, and 2 weeks before berries touch.	
	Folpet	25	NTL	WP or D	1	3	Apply 250-300 gal per acre, begin just before bloom; repeat just after bloom and at 7-10 day intervals for 1-3 more applications.	May cause injury during hot, dry weather.
	Zineb	7	7	WP or D	1.125-1.5	0.8-3	Apply just before bloom; repeat just after bloom, 10 days after bloom, and 2-3 weeks later, or at 10-14 day intervals.	

Dead arm (<i>Cryptosporella viticola</i>)	Captan	50	NTL	WP	2	—	In Northeastern States, begin when new shoots are 1-2 inches long; repeat when 4-6 inches long. In California, begin when new shoots are 6-8 inches long; repeat 2 weeks later and again before bunches close.	During periods of extended hot, dry weather, foliage injury may occur.
	Folpet	25	NTL	WP	1	—	In Eastern States, begin when new growth is 1-2 inches long; repeat when 8-10 inches long. In Western States, begin at bud break; repeat 2 weeks later, or when new growth is 4-8 inches long.	
Downy mildew (<i>Plasmopara viticola</i>)	Bordeaux mixture	Exempt	NTL	*	6 copper sulfate + 6 lime	—	Begin when new growth is ½ inch long; repeat at 2-week intervals.	
				WP	16-20 of 12.75% copper in WP formulation	—		
	Captan	50	NTL	WP or D	1	1.1-2.1	Make two applications before blossoming and 3 or 4 applications at 10-15 day intervals after bloom.	

* Does not apply.

Pesticides for control of diseases and insects of grapes—Continued

INSECT	PESTICIDE	TOLER- ANCE (p/m)	MIN. DAYS FROM LAST APPLI- CATION TO HAR- VEST OR FEED- ING	FORMU- LATION	POUNDS OF ACTIVE INGREDIENT TO APPLY UNLESS OTHERWISE INDICATED		WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
					PER 100 GAL	PER ACRE		
Powdery mildew (<i>Uncinula necator</i>)	Folpet	25	NTL	WP	1	—	Apply 250-300 gal per acre. Begin just before bloom; repeat just after bloom, and at 7-10 day intervals for 1-3 more applications.	During periods of extended hot, dry weather, foliage injury may occur.
	Zineb	7	7	WP or D	1.125-1.5	0.8-3	Apply just before bloom; repeat just after bloom, 10 days after bloom, and 2-3 weeks later, or at 10-14 day intervals.	
	Dinocap	Extend- ed 0.1(N)	21	WP	*	0.57	On varieties susceptible to powdery mildew and tolerant of sulfur, 2-3 sprays before flowering and 1 after will general- ly control powdery mildew throughout the season.	
	Wettable sulfur	Safe	NTL	WP or D	4-6	5-10	Programs for black rot and downy mildew using bordeaux mixture, captan, zineb, or folpet usually control powdery mildew.	During periods of hot weather, foliage injury may occur.

*Does not apply

Bitter rot (<i>Melanconium fuliginum</i>)	(See Safety Restrictions.)				In vineyards where bitter rot is severe, apply bordeaux mixture (4-4-100) a month before harvest and a spray of captan or zineb 2 weeks later.	If spray schedule for control of black rot is followed, this disease usually does not become a problem.
Anthracnose or Bird's-eye rot (<i>Elsinoe ampelina</i>)	Lime-sulfur	Safe	NTL	L	2 qt of 26-31% suspension	Apply during dormant season, then 4 or 5 applications of bordeaux mixture (4-4-100) or ferbam (2 lb) in growing season.

CAUSAL ORGANISMS OF GRAPE DISEASES

<i>Disease</i>	<i>Causal organism</i>
Anthracnose or bird's-eye rot	<i>Elsinoë ampelina</i>
Bitter rot	<i>Melanconium fuligineum</i>
Black rot	<i>Guignardia bidwellii</i>
Cercospora leaf spot or angular leaf spot	<i>Mycosphaerella angulata</i>
Crown gall	<i>Agrobacterium tumefaciens</i>
Dead arm	<i>Phomopsis viticola</i>
Downy mildew	<i>Plasmopara viticola</i>
Powdery mildew	<i>Uncinula necator</i>
Ripe rot	<i>Glomerella cingulata</i>

COMMON AND SCIENTIFIC NAMES OF INSECT PESTS OF GRAPES

<i>Common name</i>	<i>Scientific name</i>
Grape apple gall maker	<i>Schizomyia vitispomum</i>
Grape berry moth	<i>Paralobesia viteana</i>
Grape cane gall maker	<i>Ampelogypter sesostris</i>
Grape curculio	<i>Craponius inaequalis</i>
Grape flea beetle	<i>Altica chalybea</i>
Grape leafhopper	<i>Erythroneura comes</i>
Grape mealybug	<i>Pseudococcus maritimus</i>
Grape phylloxera	<i>Phylloxera vitifoliae</i>
Grape rootworm	<i>Fidia viticida</i>
Grapevine aphid	<i>Aphis illinoisensis</i>
Japanese beetle	<i>Popillia japonica</i>
Midges or gnats	<i>Cecidomyia viticola</i>
	<i>Dasineura vitis</i>
	<i>Lasioptera vitis</i>
Redbanded leafroller	<i>Argyrotaenia velutinana</i>
Rose chafer	<i>Macrodactylus subspinosus</i>

This bulletin is addressed to commercial grape growers. Home gardeners should consult their local Agricultural Extension Service if they need help in identifying the pests and diseases that are damaging their grapes or in selecting the proper insecticide.

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